

# GUIDELINES TO STRENGTHEN AND RETROFIT YOUR HOME

*Before the next Earthquake*



*Includes*  
*Foundation Systems*  
*Chimney Repairs*  
*Protecting Contents*





## **Disclaimer**

This publication was funded by the California Governor's Office of Emergency Services and the Federal Emergency Management Agency to illustrate basic retrofit techniques. It is not, nor can any publication be, a substitute for evaluation of a structure by a registered structural engineer or licensed architect, evaluation of a site by a registered geologist or soils engineer, or retrofit by licensed construction professionals.

Because the science of earthquake engineering is not sufficiently developed to enable precise prediction of an earthquake's consequences, there can be no guarantee that application of the information in this publication will safeguard people and property in an earthquake. The information in this publication has been carefully reviewed, but neither the State of California nor FEMA assumes liability for any injury, death, or property damage that results from an earthquake, or in the application of recommendations contained in this publication.

Neither Fema nor the State of California promote the sales of any name brand products or company's that may be shown in this document.

## **ACKNOWLEDGMENTS**

These materials were developed and refined after a number of California earthquakes: Humbolt County, Landers/Big Bear, Northridge and Napa, by the Earthquake Program and Hazard Mitigation staff of the California Governor's Office of Emergency Services and the Federal Emergency Management Agency, Regions IX and X. These mitigation staffs worked closely, and coordinated efforts with the local building officials in each of the affected counties and municipalities to assure that local building codes and ordinances then in force, were incorporated into the document.

**GUIDELINES  
TO STRENGTHEN  
AND  
RETROFIT YOUR HOME**

***BEFORE THE NEXT EARTHQUAKE***

Developed by the  
Governor's Office of Emergency Services

State of California

And

Federal Emergency Management Agency

Revised  
October, 2000

## **INTRODUCTION**

Are you worried about the earthquake safety of your home?

If you are concerned about how your home will perform in future earthquakes, please take a few minutes to read the enclosed materials. Better yet, resolve to spend a little time and money to use some of the tips on these pages. Anything you can do now to your home and its contents, will save you from damage and disruption later.

Earthquakes will strike again, but their effects to homes and dwelling places need not be disastrous. Much of the damage to houses and apartments in recent earthquakes could have been prevented. The drawings inside this booklet show how.

Now is the time to strengthen your home correctly. If you had damage in a past earthquake, repair it according to the directions here. If your home survived an earthquake without damage, it is still a good idea to evaluate it and take steps to strengthen any vulnerable spots you find.

### **How can this information be used?**

This guidebook is a collection of retrofit and strengthening methods that can help lessen or prevent damage to your home from earthquakes. In the package you will find many drawings showing examples of how various elements of your house can be made safer. You can use this book as a guide when discussing with your design professional, contractor, building official or other person experienced with home construction.

The details presented in this package have been developed for general construction conditions and may not apply to every building or structure. Further, the details have been developed assuming that all components will be installed as noted and shown. This guide does not identify every potential solution in retrofitting or strengthening your home. You are encouraged to contact your local building department about using any of these details or modifying them to fit your specific building conditions and your local building codes.

The information in this guidebook is not a substitute for professional structural design services or an evaluation by a registered civil or structural engineer or a licensed architect. Protect yourself by using the services of competent and licensed professionals, and read the flyer at the end of this document on selecting a contractor .

Remember that all structural repair work requires a building permit issued by your local building department. In many cases, repair of damage to electrical and mechanical systems will also require a building permit. If you have any questions regarding the permit or repair process, call your local building department.

## TABLE OF CONTENTS

Sill Plate Bolting.....	1
Cripple Wall Bracing.....	3
Bracing Systems for “Post and Pier” Foundations.....	5
Chimneys and Vents.....	8
Wood Burning Stoves.....	14
Anchoring Water Heaters.....	15
Utilities and Household Contents.....	16
Anchor Propane Tank.....	17
Anchor Tall Bookcases and File Cabinets.....	18
Install Latches on Drawers and Cabinets.....	19
Mount Framed Pictures and Mirrors Securely.....	20
Restrain Desktop Computers and Appliances.....	21
Manufactured Homes (Mobile Homes).....	22
Shopping List.....	24
Special Notes.....	25
What is a Geologist?.....	27

# SILL PLATE BOLTING

## Materials & Tools Needed

½” diameter expansion bolts of a style acceptable to the local building department. Length of bolt determined by depth of hole, thickness of sill plate, and a projection of not less than 1” above sill plate

Masonry drill bit with carbide tip. Size determined by size and style of expansion bolt

Electric rotary impact drill or heavy-duty drill

Short-handled sledgehammer or carpenter’s

hammer for setting the bolts

3/8” diameter plastic tubing

Adjustable crescent wrench

Chalk or Lumber crayon

Measuring tape

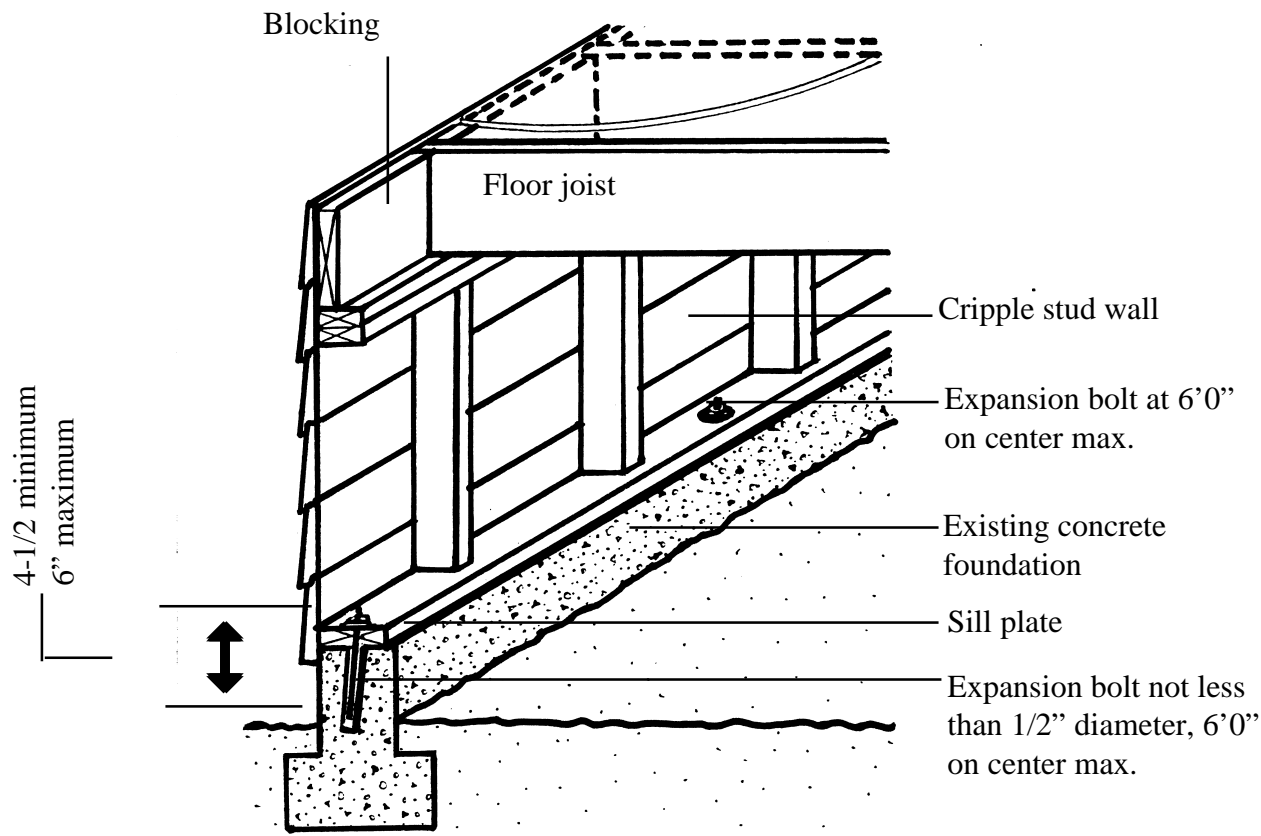
Eye protection

Noise protection

## Installation Instructions

1. Lay out bolt locations. Bolts should be spaced at not more than 6’-0” apart. Begin layout at not less than 4” or more than 12” from the end of any section of sill plate.
2. Drill holes through the sill plate and into the foundation with a carbide drill bit of the size recommended for the style of expansion bolt used. Drill holes a minimum of 4-1/2” into foundation wall.
3. After drilling a hole, clean out the concrete dust by inserting the 3/8” diameter plastic tubing into the hole and blowing out the dust.
4. Place cut washer over the bolt so it rests on top of the sill plate. Place the nut on the bolt and turn until the top of the nut is even with the top of the bolt. Insert expansion bolt into the hole until it stops. Using the sledgehammer or carpenter’s hammer, strike the top of the bolt until it is firmly set at the bottom of the hole.
5. Using a crescent wrench, tighten the nut until the sill plate begins to crush under the washer.

# SILL PLATE BOLTING



## CRIPPLE WALL BRACING

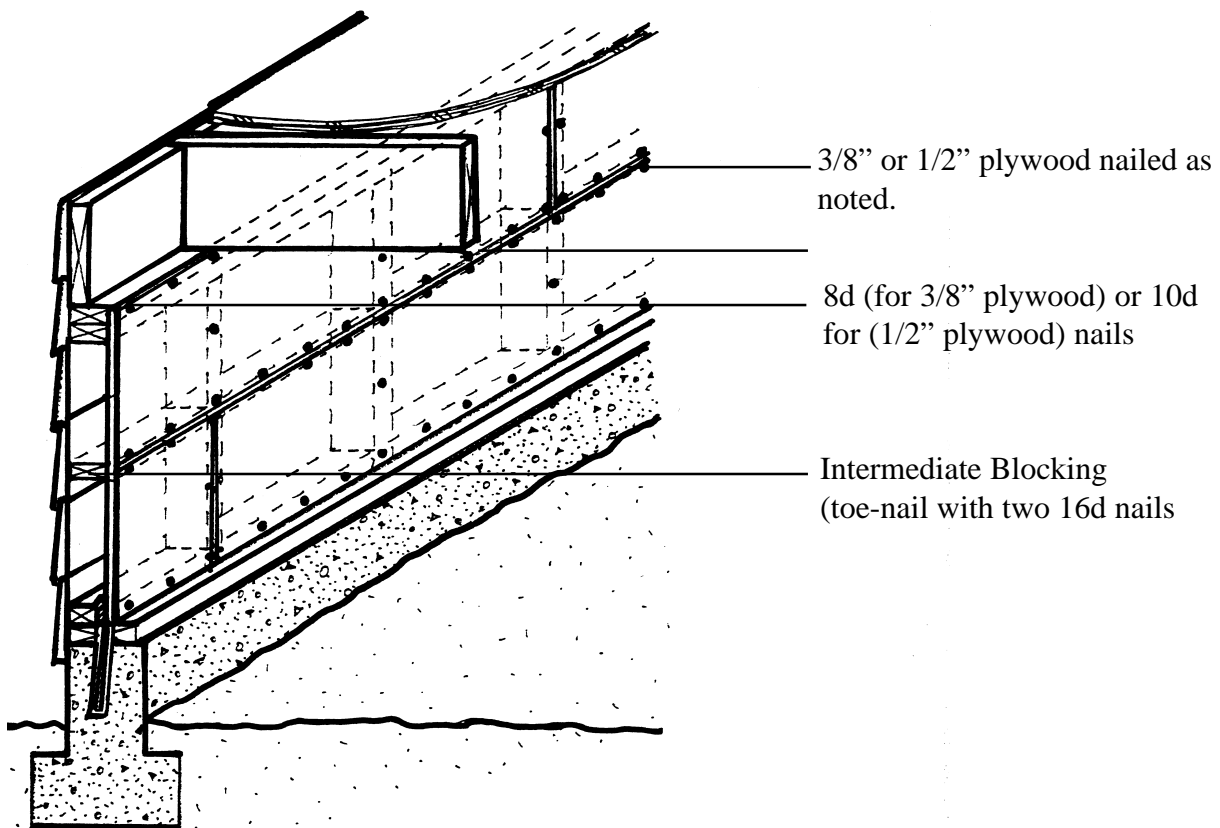
### Materials and Tools Required:

3/8" or 15/32" thick plywood of Structural I or CDX grade	Electric drill
Nominal 2" thick lumber (actually 1-1/2" thick) the same depth as the studs. This will be used for blocking, if required (see note above)	1/16" diameter drill bit for pre-drilling nail holes if blocking is required
8d common nails for use with 3/8" plywood	Nail gun or carpenter's hammer
10d common nails for use with 15/32" plywood	Measuring tape
16d common nails for use with blocking, if required	Chalk, lumber crayon or pencil
Electric circular saw	1-1/2 -2" diameter hole saw

### Installation Instructions:

1. If access to the crawl space under the house is such that full-width sheets, or sheets cut to the height of the cripple studs, will not fit, cut plywood sheets lengthwise to a width not less than 18".
2. If sheets need to be cut, blocking will be necessary. Cut the 2" nominal thickness lumber to fit snugly between the studs. Nail each block to the studs with 2 16d nails at each end. Nails should be driven on an angle from the top of the blocking into the side of the stud. Pre-drilling for the nails will make this operation easier.  
Blocking should be installed at the same height for the full length of the plywood sheet.
3. Starting at a corner, measure across the studs to find where the sheets of plywood can butt. In order to do this, find the stud closest to, but not less than 4', or closest to, but not more than 8' from the corner. Measure the location of all ventilation vents and cut out holes in the plywood to match the vents.
4. Mark the location of each stud at the top plate and on the foundation wall with chalk or lumber crayon.
5. After cutting the plywood to fit, lay it up against the studs and hand nail a nail in each corner of the plywood to hold it in place. Using a nail gun, or a carpenter's hammer, place a nail every 4" around the perimeter of the plywood sheet. Then place a nail every 6" along each stud. Use the nails appropriate for the thickness of the plywood.
6. Once the plywood has been fully nailed, drill a 1-1/2" to 2" diameter hole between each stud at the top and bottom of each plywood sheet to provide ventilation. If you have had to use blocking, drill a 1-1/2" to 2" diameter hole above and below the blocking.

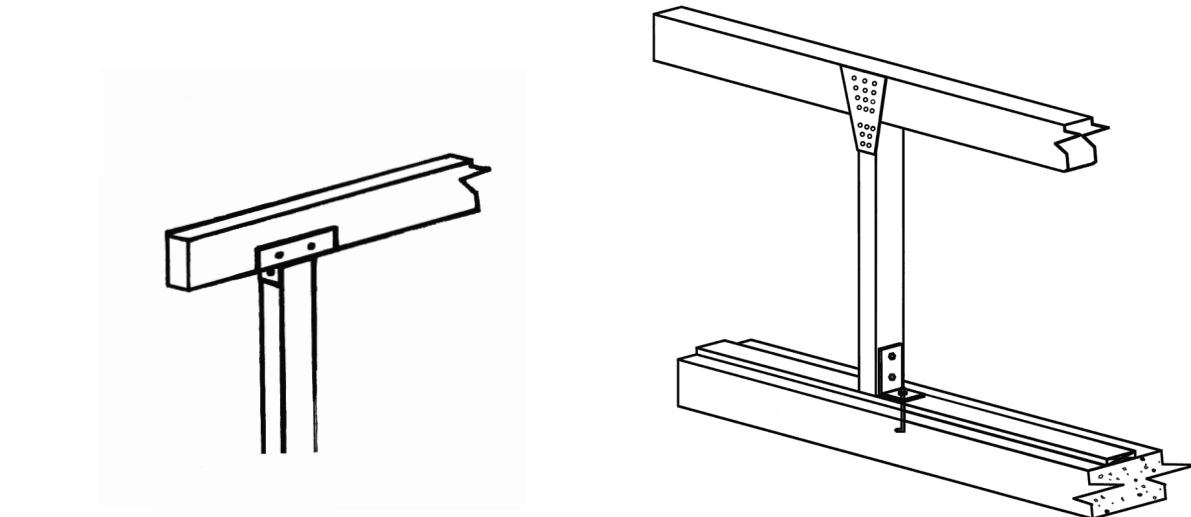
## CRIPPLE WALL BRACING



**Note:**

The size of access to the average crawl space frequently doesn't allow for the placement of large pieces of plywood. You may need two or more smaller pieces of plywood. When multiple pieces are used to cover the height of the wall, blocking must be installed at the joint and completely nailed. If a single piece of plywood can be installed the full height of the cripple stud, blocking will not be necessary.

## BRACING SYSTEMS FOR “POST AND PIER” FOUNDATIONS

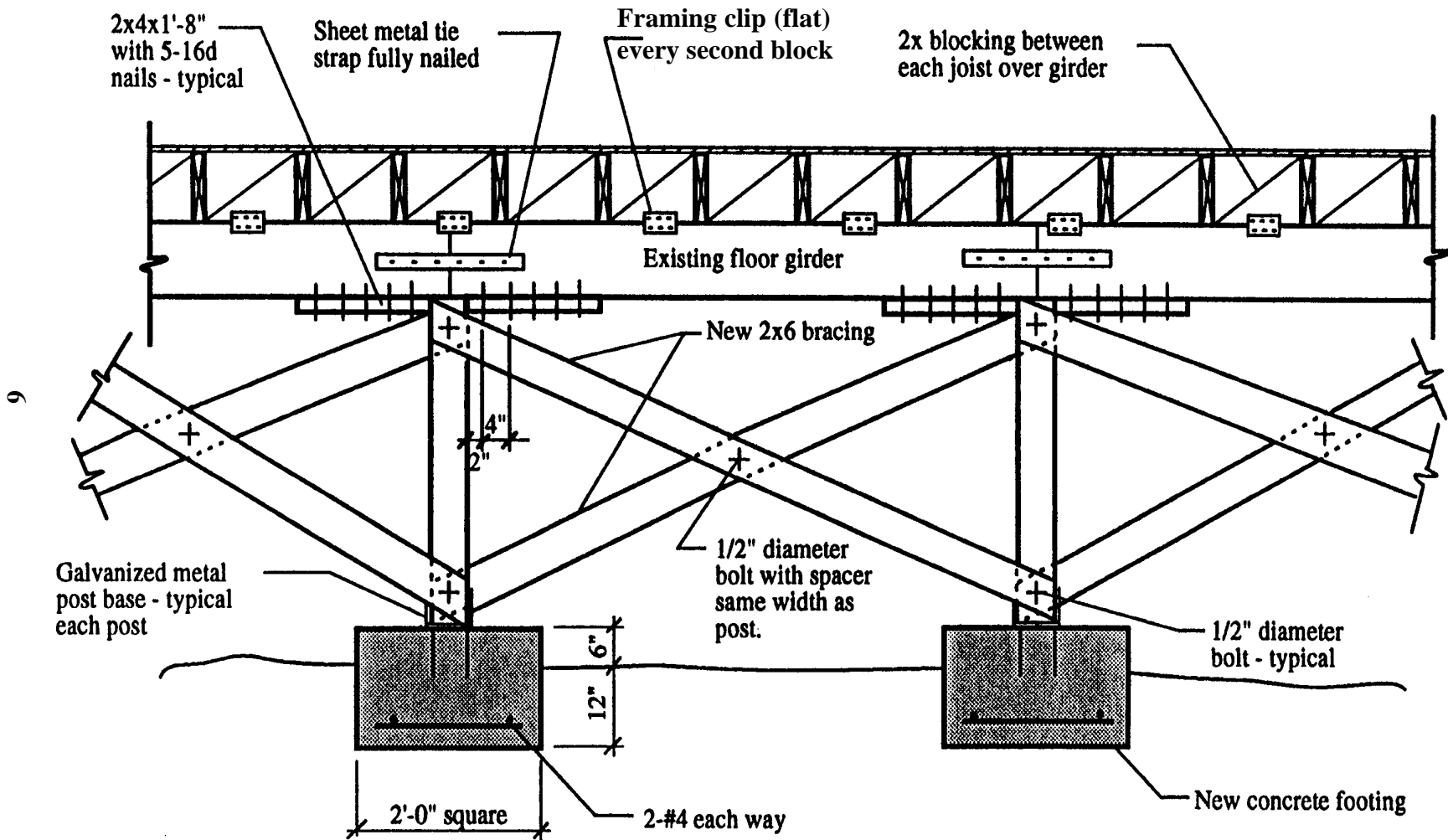


A “post and pier” foundation consists of wood posts which support the entire structure and are, in turn, supported on isolated concrete footings. This type of foundation system does not have continuous perimeter foundations nor does it include a substantial bracing system to resist lateral forces from earthquakes or wind.

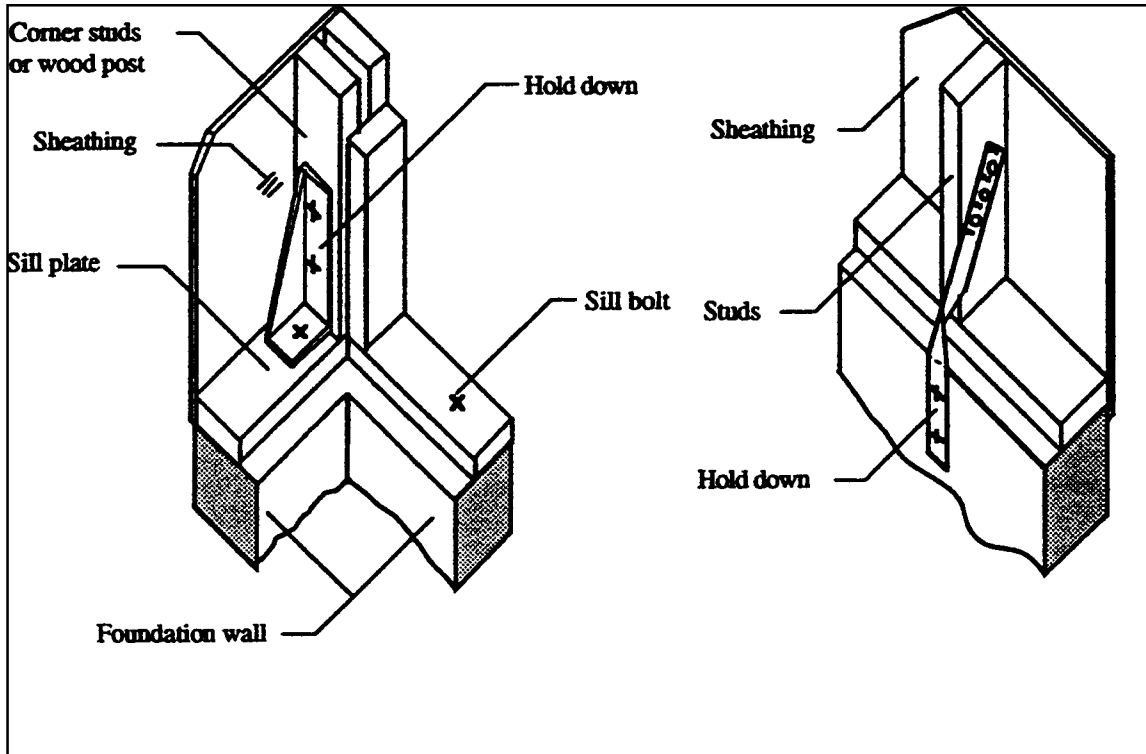
If your home has this type of foundation, and was knocked off its posts and piers during the recent earthquake, contact your local building department to find out the required repair. Most likely it will be required that you install a continuous perimeter foundation.

There is no question that the best foundation system for any structure is a continuous perimeter foundation. With a continuous perimeter foundation the structure can, and usually does, have isolated “post and pier” systems on the interior that are not braced. The continuous perimeter foundation keeps the structure from moving laterally which is the cause of wood post tilting.

# POST AND PIER-INTERIOR BRACING



## ALTERNATIVE HOLD DOWNS



### Exterior Features and Other Components

There are many features of your home that you can check and strengthen. These include the "extras" on your house such as porches, front and back decks, canopies and carports, and small rooms or additions made to the house after it was originally built.

The connections of these features to the main house may have been damaged in the recent earthquakes, even if the main structure of your house was not damaged. If you suspect damage to these exterior features, contact your local building department for advice on evaluating the damage, obtaining permits, and making the repairs. Even if it appears that these features may not have been damaged, it is a good idea to have the features evaluated by a civil or structural engineer or an architect who can suggest cost effective strengthening measures.

## CHIMNEYS AND VENTS

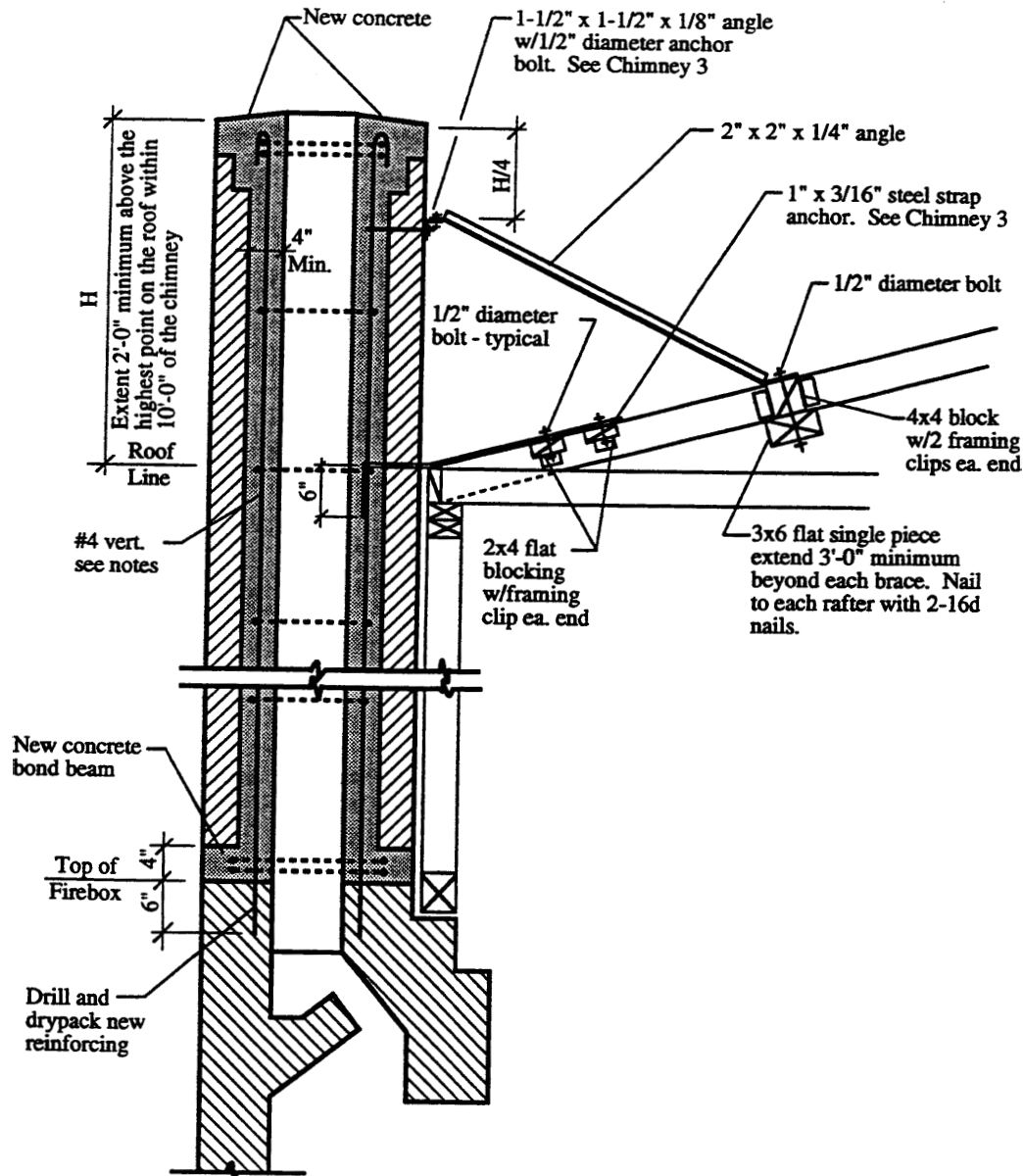
Masonry chimneys are extremely vulnerable to earthquake damage, especially those parts which are free-standing above the roof-line. Chimney failure was common throughout the earthquake damaged area. Many older chimneys, which were damaged by the earthquake, were in a weakened condition because the mortar had deteriorated and because they were unreinforced. Newer, reinforced chimneys were also vulnerable where they extended above the roof-line.

This section includes a number of options that can be used to retrofit and strengthen masonry chimneys.

1. Remove the entire chimney and replace it with a new low or zero clearance metal flue contained within a wood framed chase. Typically, this chase is covered with the same finish material as the house. Your local building department can assist you in meeting local code requirements and with construction detail.
2. If the chimney fractured between the roof line and the top of the fire box, reconstruct the damaged portion of the chimney as required by local code and strengthen with ties and roof bracing. See Chimney 1 and 3.
3. If the chimney fractured above the roof line, reconstruct the damaged portion of the chimney as required by local code and strengthen with ties and roof bracing. See Chimney 2 and 3. For multi-story homes when the fracture occurred below the roof line, but above the floor line of the top floor, a repair similar to that shown in Chimney 2 can be employed. Instead of removing the chimney to 1'-6" minimum below the roof line, remove it to 1'-6" below the floor line closest to, and below, the fracture.
4. As an alternative to a masonry chimney, the damaged portion can be removed and reconstructed utilizing the salvageable masonry portion and installing a metal chimney above, as approved by your local building department. See Chimney 4.
5. Even if your chimney was not damaged in the recent earthquake you should consider strengthening it with metal braces attached to the roof. See Chimney 1 and 2

Your chimney may not be visibly damaged, however, it may be cracked. Have your chimney checked before using the fireplace again. A cracked chimney may mean a cracked flue which can be a high fire hazard. Additionally, combustion of wood products emits toxic gases which, if the flue is cracked, could escape into the house creating a serious health hazard. These hazards are not limited to masonry chimneys but apply to metal chimneys as well. Also, vents associated with any appliance that burns gas, such as water heaters, gas stoves, gas heaters, etc., could be susceptible to the same damaged hazards. All of these vents should be inspected at the same time that the chimney is inspected.

# CHIMNEY REPAIR WHEN FRACTURED BETWEEN ROOF LINE AND TOP OF FIREBOX CHIMNEY 1

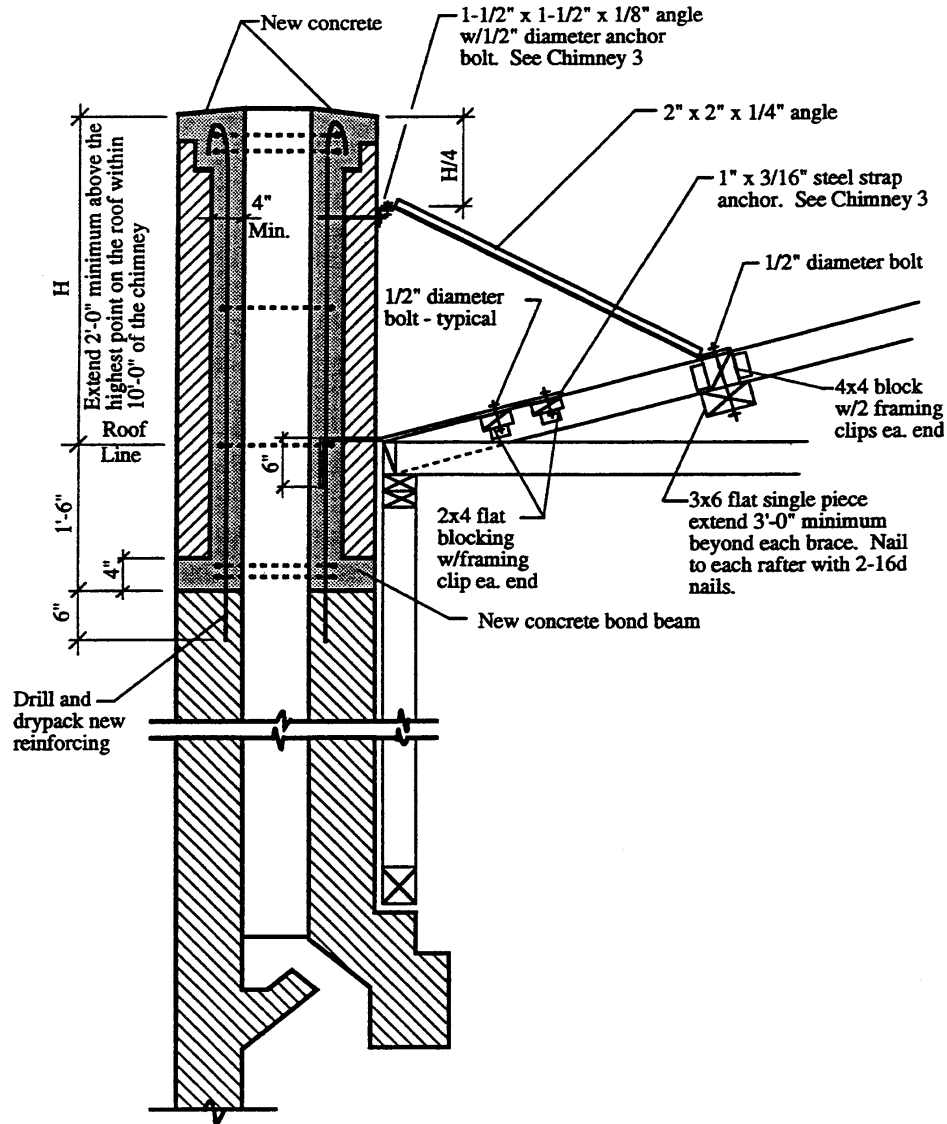


## Notes:

1. See chimney 3 for spacing of vertical reinforcing, steel anchor straps, and angle bracing.
2. Remove chimney to top of firebox.
3. Drill minimum 1" diameter holes 6" deep in remaining masonry. Holes to be drilled at each vertical bar location. Set vertical bars in holes and pack tightly with drypack. Tie vertical bars as shown.
4. Pour bottom concrete bond beam to create a base to rebuild removed portion of chimney.
5. Form and pour concrete to top of chimney.
6. Connect ledger, brace and anchor straps. Wherever connections penetrate the roof, these areas will have to be treated to prevent water leakage.

# CHIMNEY REPAIR WHEN FRACTURED BETWEEN ROOF LINE AND TOP OF CHIMNEY

## CHIMNEY 2



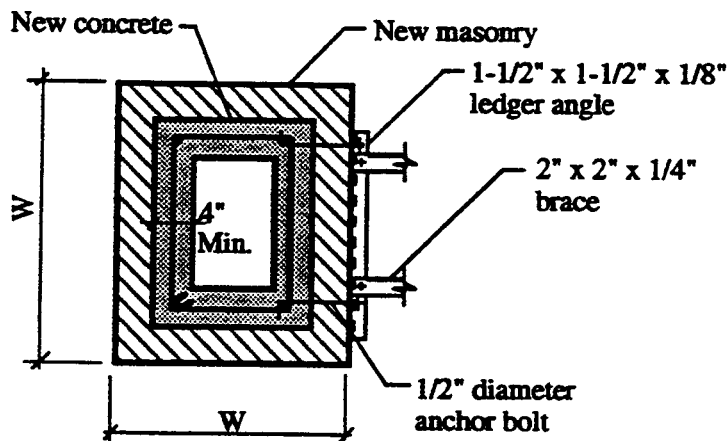
### Notes:

1. See chimney 3 for spacing of vertical reinforcing, steel anchor straps, and angle bracing.
2. Remove top portion of chimney to a minimum of 1'-6" below the roof line.
3. Drill minimum 1" diameter holes 6" deep in remaining masonry. Holes to be drilled at each vertical bar location. Set vertical bars in holes and pack tightly with drypack. Tie vertical bars as shown.
4. Pour bottom concrete bond beam to create a base to rebuild removed portion of chimney.
5. Form and pour concrete to top of chimney.
6. Connect ledger, brace and anchor straps. Areas where connections penetrate the roof, will have to be treated to prevent water leakage.

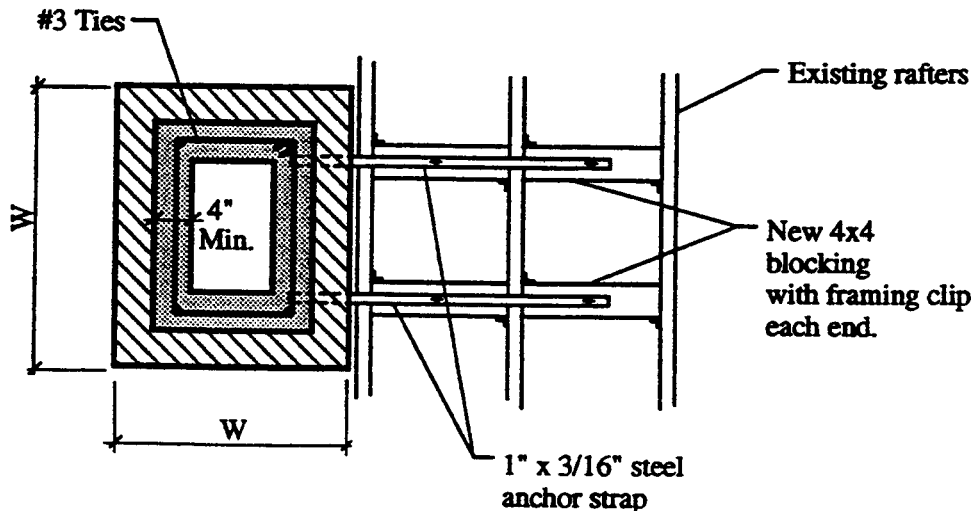
## MISCELLANEOUS DETAILS

### CHIMNEY 3

	CHIMNEY WIDTH (W)		
	Up to 3'-4"	Over 3'-4" to 6'-8"	Up to 6'-8"
Vertical Reinforcing	1-#4 in each corner	1-#4 in each corner and 1-#4 in center of long faces	1-#4 in each corner and 1-#4 at third points on long faces
Steel anchor straps	1 each end of wide face	1 each end and 1 in center of wide face	1 each end and at third points on long faces
Angle braces	1 each end of wide face	1 each end and 1 in center of wide face	1 each end and at third points on long faces

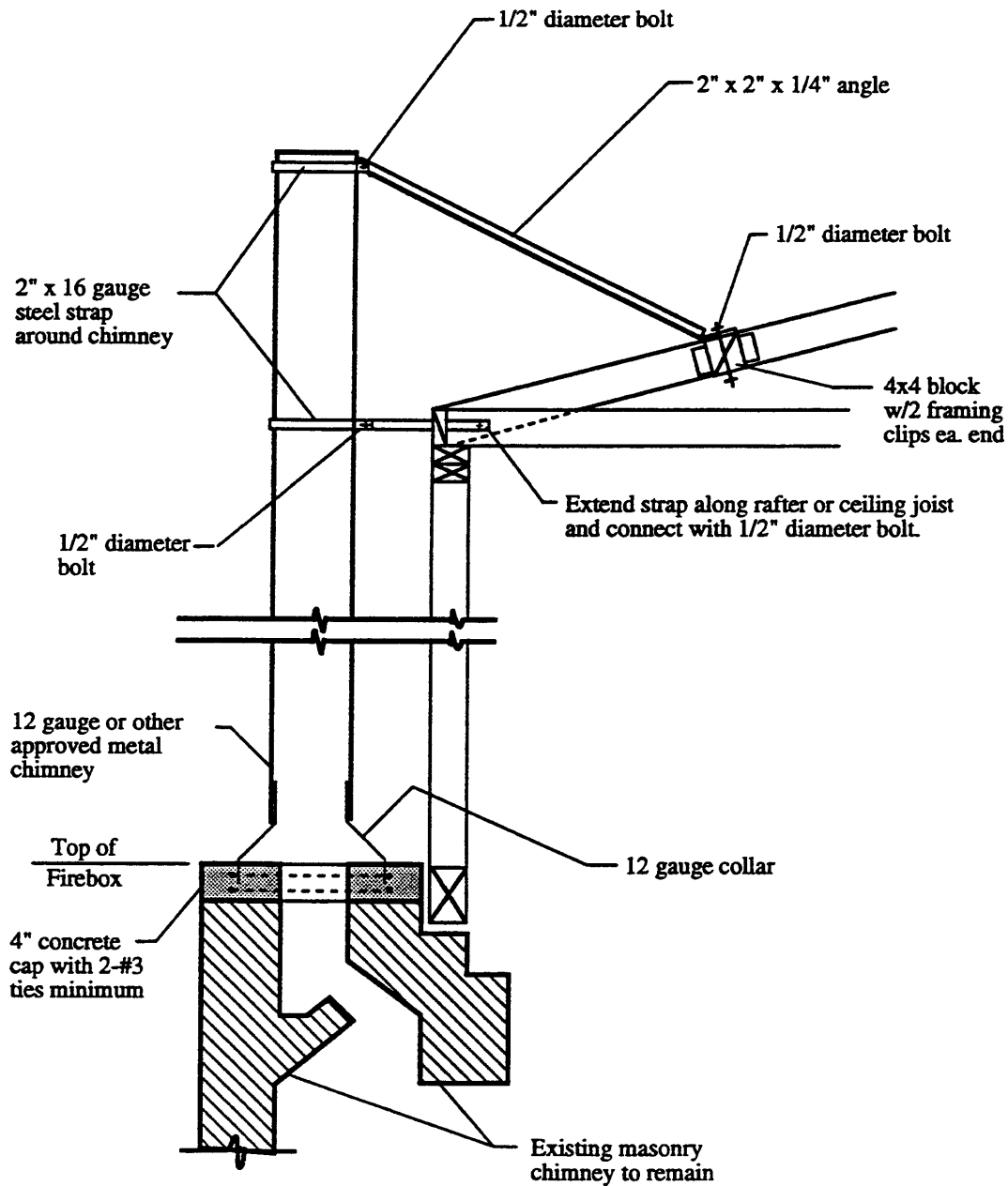


**Plan at Chimney Bracing**



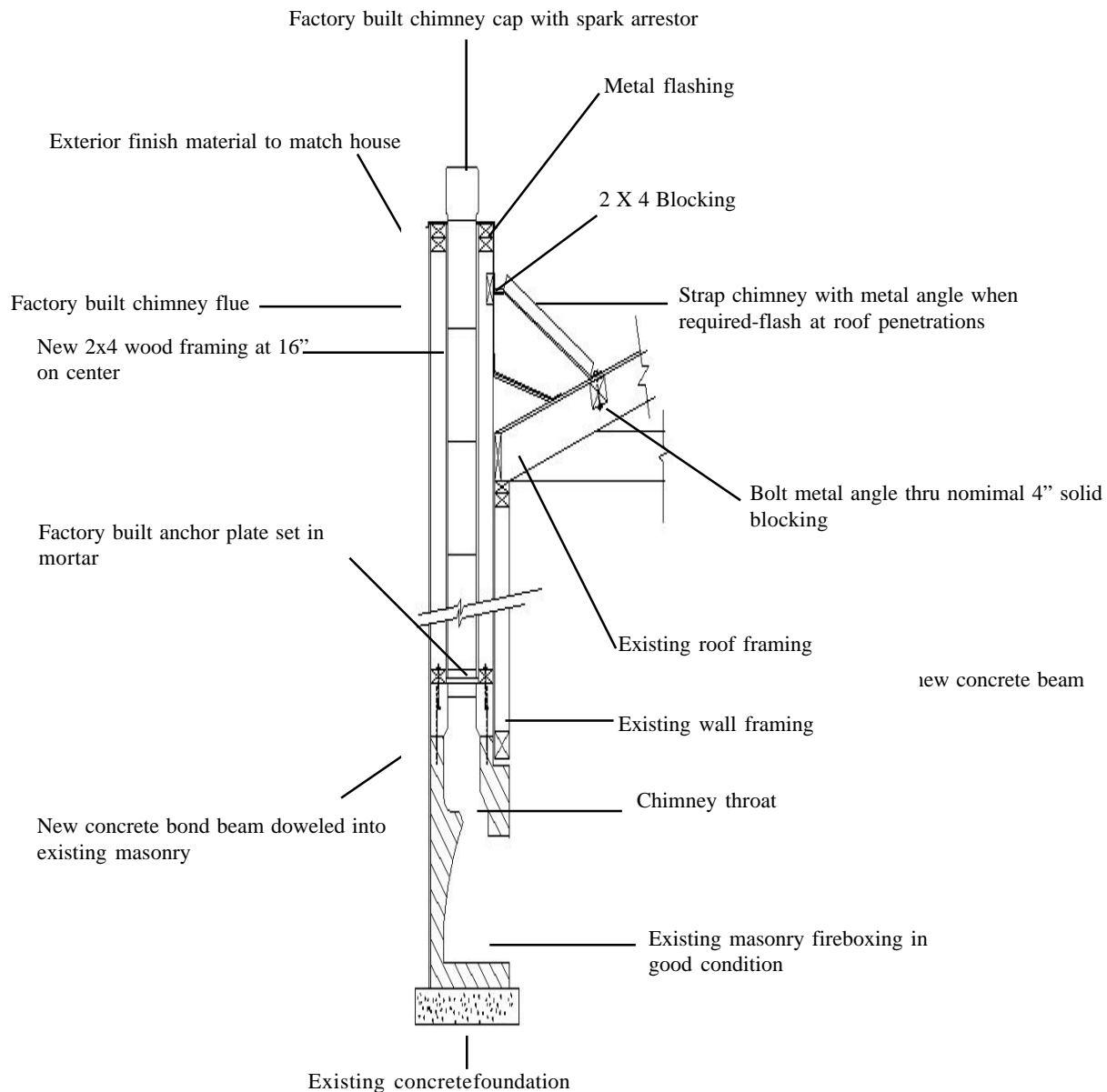
**Plan at Anchor Straps**

# **CHIMNEY REPAIR WHEN REPLACING MASONRY CHIMNEY WITH NEW METAL CHIMNEY CHIMNEY 4**



## CHIMNEY BRACING MASONRY CHIMNEY

There is not a totally effective way to prevent earthquake damage to an unreinforced masonry chimney. The most effective mitigation measure is removal of the masonry chimney down to the top of the firebox and installation of a factory built metal flue enclosed in conventional 2x4 wood framing.



### Notes:

For additional requirements, consult your local building department.

## WOOD BURNING STOVES

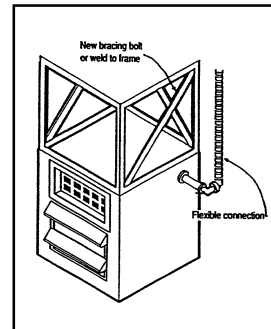
Freestanding stoves are in common use for residential heating. A variety of stoves are available including wood burning stoves, pellet stoves or gas-fired units. Except for zero clearance units, mobile home approved units, and other installations where special insulation is provided, fire codes require at least 36-inch clearance around the stove and 18-inch clearance around a single wall stovepipe. This arrangement leaves the stove unsupported on all four sides and vulnerable to sliding or overturning in an earthquake. If the stove were to tip and/or separate from the stovepipe, cinders or sparks might easily cause a fire in the home.

In order to reduce the potential fire hazard following an earthquake, the stove should be anchored to the floor and the stovepipe sections secured to prevent separation, but it is important that the seismic anchors or braces do not conduct heat from the stove to the combustible materials in the home. Although there are many types of stoves in use, the following recommendations can be used for some common installations:

- 1 Stoves resting on a brick hearth can be anchored using additional bricks and mortar.
- 2 Mobile home approved units (which are built with extra internal shielding) come with predrilled holes in the pedestal or legs and can be safely anchored to the underlying floor framing using 3/8-inch diameter bolts with oversized 2-inch diameter “fender” washers on the underside of the wood flooring.
- 3 Stoves resting on a concrete slab can be anchored directly to the concrete using 3/8-inch diameter expansion anchors embedded 3-inches into the concrete.
- 4 Stovepipes should be securely anchored to the flue exit and each of the stovepipe segments should be securely anchored together with sheet metal screws (for double walled pipe make sure the screws are short enough so they do not penetrate the inner pipe wall).
- 5 If the stovepipe is unsupported for more than 8-feet from the stove to the ceiling, provide one mid-height support by running the stovepipe through a readymade attic radiation shield that is braced to the wall to prevent lateral movement.
- 6 For configurations other than the ones discussed above, consult your stove vendor and/or local fire department.

### Flexible Water and Gas Lines

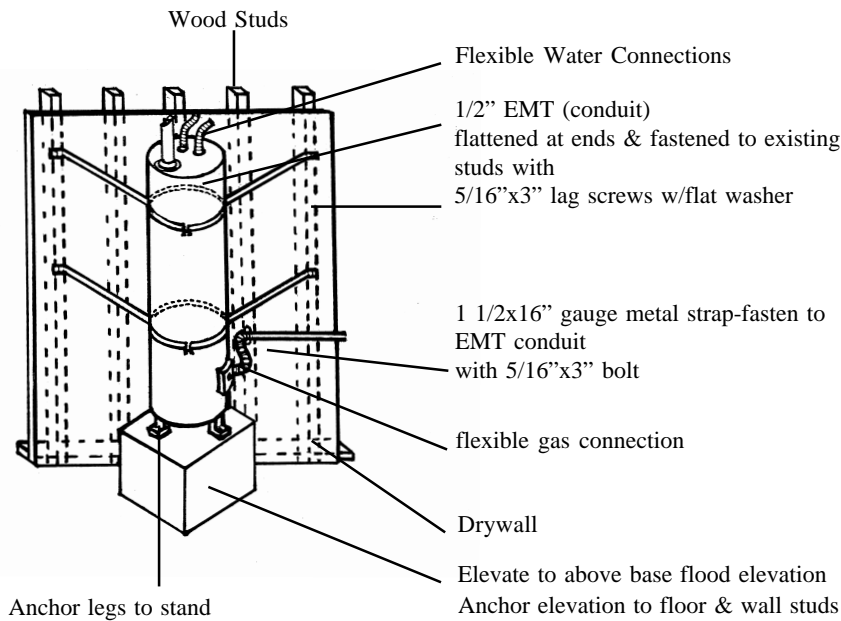
During an earthquake both the ground and the houses are going to move and shake. Most water and gas lines are rigid and the pipes could be torn from their connection points. The solution is simple and cheap: a flexible connection pipe can be installed, by a licensed contractor, between the appliance and the wall to minimize the potential of broken connections which can lead to fires and water leaks.



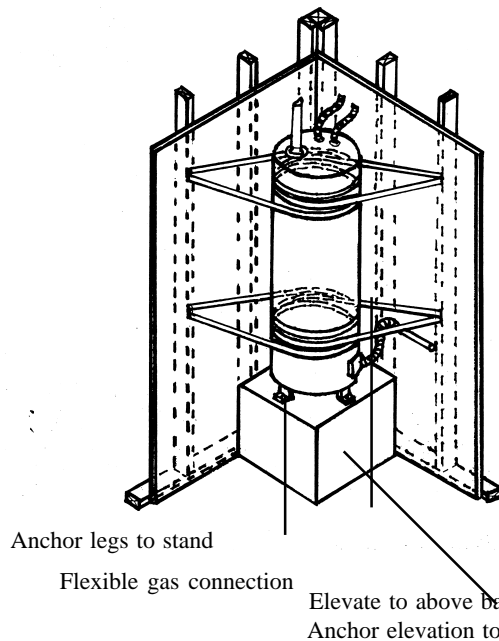
## ANCHORING WATER HEATERS

Strapping your water heater to the wall and having a flexible gas line installed will greatly reduce both danger of fire, (if you have a gas water heater) and major water damage. The straps will prevent the water heater from toppling over in the next quake, spilling water and rupturing the gas line connection.

### WATER HEATER ON FLAT WALL



### WATER HEATER IN A CORNER



1. These Illustrations apply to a 30-40 gallon water heater within 12" of stud wall.
2. Use a small finish nail or stud finder to locate center of studs.
3. Elevate water heater to required flood codes.
- (4) - 22 Gauge Metal Strapping Tape, 2 top & 2 bottom, encircling tank as shown-fasten to 1st wall stud not behind the water heater with 5/16"x3" lag screws & flat washer

**Note:** Consult your local building department

## UTILITIES AND HOUSEHOLD CONTENTS

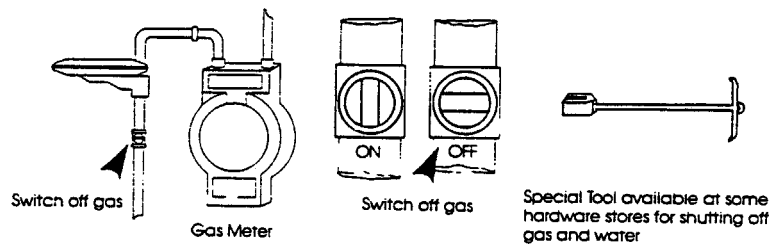
This section describes a number of ideas for improving earthquake safety inside your home. Most of these ideas are simple projects that you can do yourself. The cost is low, and the safety improvement can be high.

### Utilities Shut-Off

There is no cost involved in teaching everyone in your home about how and when to turn off the gas, electricity, and water after an earthquake. This can be as simple as clearly marking where these shut-off valves are, and posting instructions close by. Below are three common examples of shut-off valves. Even if you have something different, like a propane tank, the shut-off will be similar. If you cannot find the shut-off valves, or you do not understand the valve system, call your local utility company or tank provider. Remember, you only need to shut off your utilities if you can smell gas, or see damage to or near the utility lines.

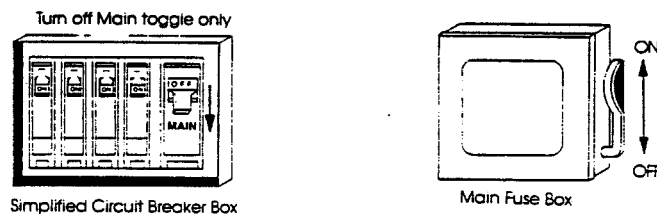
---

#### GAS SHUT-OFF



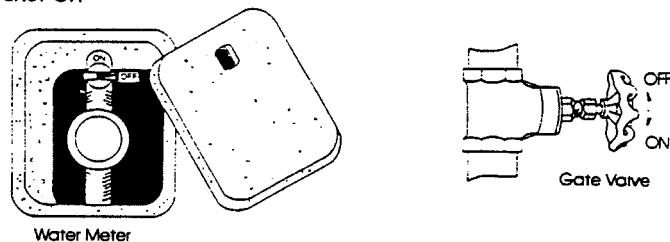
---

#### ELECTRICAL SHUT-OFF



---

#### WATER SHUT-OFF



---

#### MATERIALS NEEDED:

White or Fluorescent Paint

#### TOOLS NEEDED:

Crescent Wrench  
Long Screw Driver or Specialty Tool  
for Gas and Water

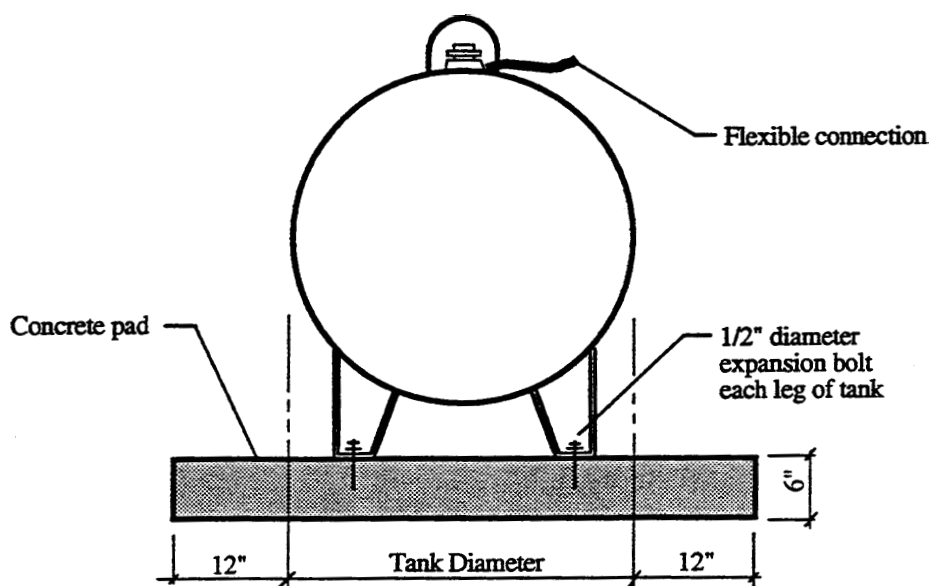
Reproduced with permission from: "Home Earthquake Preparedness Guide," EQE Engineering & Design, San Francisco, CA.

## ANCHOR PROPANE TANK

Many rural homes use propane to provide fuel for cooking, heating and operation of gas appliances. Residential propane tanks are potentially vulnerable to earthquake damage unless both the tank and the attached piping are properly secured. These tanks can slide, rock or overturn during an earthquake, possibly rupturing the tank or breaking the supply line. Gas leaks are frequently the cause of earthquake related fires.

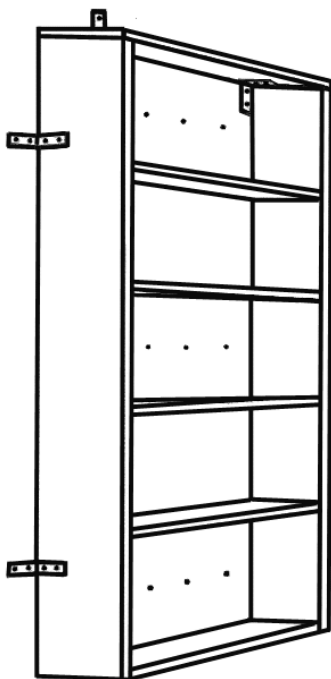
The following recommendations can be used to reduce the post-earthquake fire hazard associated with residential propane tanks:

1. Mount the tank on a continuous concrete pad and bolt the 4 legs to the pad. The concrete pad should be 6-inches thick and 1-foot wider than the tank on either side in order to provide adequate stability. For a tank of 500 gallons or less, use four 1/2-inch diameter bolts with a minimum of 3-inch embedment into the concrete pad.
2. Provide a flexible hose connection between the tank and the supply line and where the supply line enters the house to prevent potential brittle failures at these locations (as used here, *brittle failure* means the breaking of the joint allowing the gas to leak.)
3. Clear the area around the tank to ensure that there are no tall or heavy objects that could fall and rupture the tank or the supply line.
4. Keep a wrench tied on a cord near the shut-off valve and make sure family members know how to turn off the supply line if they smell a gas leak.
5. For larger tanks (i.e. farm or commercial use), a seismic shut-off valve could be installed to automatically cut the gas supply following an earthquake.



Information developed by, and reproduced with permission from ,  
Wiss, Janney, Elstner Associates, Inc., Emmerville, CA.

## ANCHOR TALL BOOKCASES AND FILE CABINETS



During an earthquake, large pieces of furniture such as tall bookcases and file cabinets can fall on you or members of your family. Toppled furniture can also block exits and prevent you from escaping. Anchoring furniture so that it remains upright not only prevents injuries but also helps protect both the furniture and its contents.

You can anchor large pieces of furniture in several ways. The figure shows how to anchor a bookcase to a wall, but the same methods can be used for other pieces of furniture. As shown in the figure, a bookcase can be anchored with metal (L) brackets and screws along its top or sides (either inside or outside) or with screws through its back and into the wall studs.

Secure your valuables with museum wax or poster putty. This is a sticky substance that secures loose items, such as nic-nacs and china, to shelving or walls. It is easy to use, leaves no residue and is reusable.

A bookcase can be anchored with metal (L) brackets and screws (either inside or outside) or with screws through its back. Make sure that all anchoring screws penetrate not just the wall but the studs behind it as well. Screws embedded only in drywall or plaster will pull out. Regardless of the anchoring method you use, the screws should be long enough to extend at least 2" into the wall and studs.

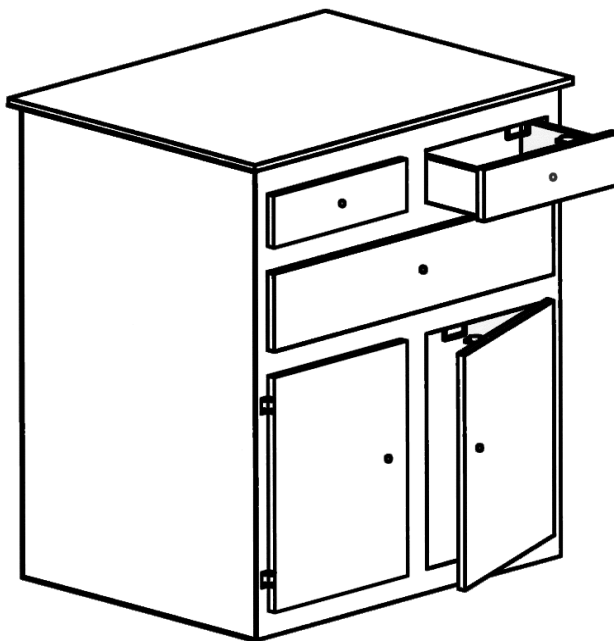
Before anchoring a bookcase with screws through its back, make sure the back is sturdy enough and that it is securely attached to the sides, top, and bottom. Some bookcases have backs made of very thin materials that are held in place with only small screws or staples that can easily pull out. Those bookcases should be anchored with brackets.

If you have two or more bookcases or file cabinets that sit next to each other, consider connecting them to one another as well as to the wall. They will be even more stable if you do.

If possible, move all bookcases, file cabinets, and other large pieces of furniture away from exits so that if they do fall, they won't prevent you from escaping.

To prevent the contents of your bookcases from falling out, you can install a thin metal or plastic rod, a wood dowel, or even an elastic band across the front of each shelf.

## INSTALL LATCHES ON DRAWERS AND CABINETS

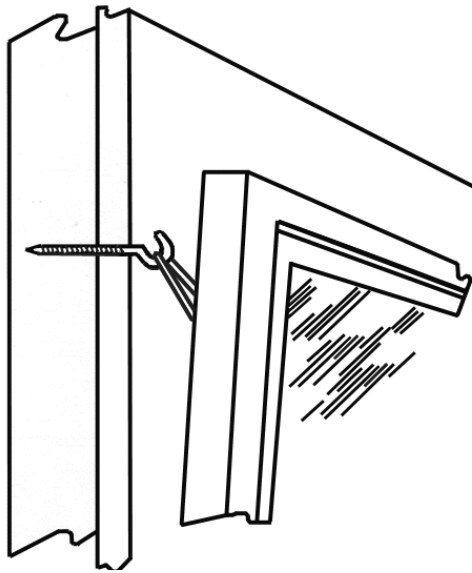


During an earthquake, drawers and cabinet doors can open and the stored materials can spill out and damage floors and floor coverings. Objects that fall from overhead cabinets can injure you or others in your household.

One way to prevent the accidental opening of drawers and cabinet doors is to install latches such as safety hasps, and childproof locks. Most hardware and home supply stores stock a variety of latches. Most types of permanent latches can be installed easily and will not interfere with opening and closing of drawers and doors.

When possible, do not store heavy, breakable, or dangerous items (such as insecticides, solvents, and bleach) in overhead cabinets. Do not rely on magnetic or pinch-grip catches to hold cabinet doors closed, especially on overhead cabinets and any cabinets that contain heavy, breakable, or dangerous items. Install latches according to the manufacturer's directions. For example, use all of the hardware provided with the latch and do not substitute undersized screws or bolts for those provided.

## MOUNT FRAMED PICTURES AND MIRRORS SECURELY



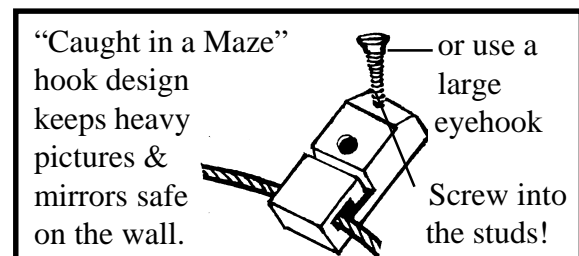
During an earthquake, framed pictures and mirrors that are not securely attached to walls can easily fall. Large pictures and mirrors can cause injuries when they fall, and the broken glass that often results increases the potential for injury.

As shown in the figure, one way to mount framed pictures and mirrors securely is to use long-shanked, open eyehooks instead of traditional picture hangers. The eyehooks must be long enough to penetrate the wall stud as well as the drywall or plaster. Eyehooks used in this way are much less likely to pull out of the wall than picture hooks installed with nails that penetrate only the drywall or plaster. Also, an alternative to running wire across the back of the picture or mirror is to use closed eyehooks securely screwed into the back of the frame. Placing Museum wax or putty on the bottom back corners of hanging items will further stabilize them.

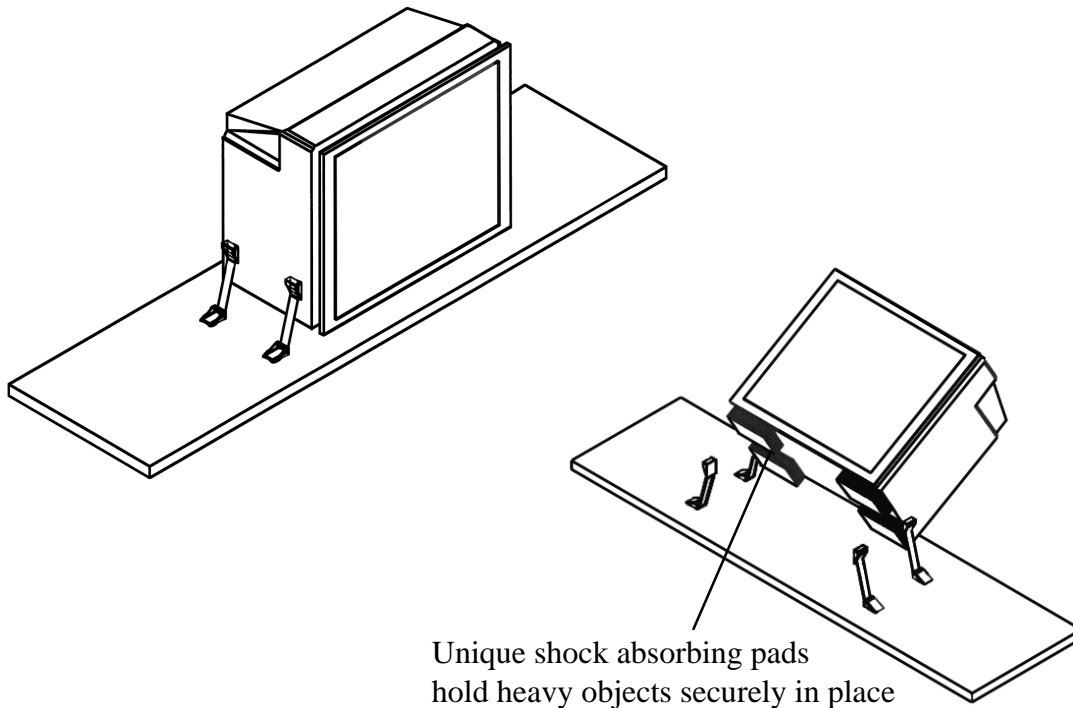
Large pictures and mirrors will be more stable when mounted on two hooks rather than one. Make sure that eye-hooks penetrate not just the wall but the studs behind it as well. Eye-hooks embedded only in drywall or plaster are likely to pull out. To be embedded deeply enough, eye-hooks should be at least 1" long.

Regardless of whether you use picture wire or closed eye-hooks on the back of the picture or mirror, make sure the hooks, screws, or other types of mounting hardware are securely attached to the frame.

For added stability, museum wax or poster putty can be applied to the bottom of the pictures or mirrors and the walls.



## RESTRAIN DESKTOP COMPUTERS AND APPLIANCES



The tremors caused by even minor earthquakes can easily move personal computer systems, stereo systems, television sets, and other small appliances that typically sit on desks, tables and countertops. If they fall, they can be damaged beyond repair.

Make sure that the desk or table the appliance sits on is not so light that it can be easily overturned. If it is, and you can't move the appliance to another location, consider anchoring the desk or table to the floor or wall.

If you want to use a wall-anchored chain, cable, or cord, attach it to a closed eyehook screwed into the wall or to a wall mount (such as a ring or plate) attached with screws that are long enough to penetrate not just the wall but the studs behind it as well.

Use stick-on straps and shock absorbing pads to anchor T V and computer monitor as well as microwave ovens.

## **MANUFACTURED HOMES (MOBILE HOMES)**

Neither State law nor regulations require manufactured homes, also called mobile homes, to be installed with bracing systems to resist the forces of earthquakes. Therefore, if some precautions are not taken, these types of homes can be particularly susceptible to damage during moderate and major earthquake activity.

The California Department of Housing and Community Development (HCD) certifies Earthquake Resistant Bracing Systems for manufactured homes. These systems have been found to substantially reduce damage to homes from earthquakes. For more information on the systems certified by HCD contact their Southern Area Office in Riverside at (909) 782-4420 or the Northern Office in Sacramento at (916) 255-2501.

Manufactured homes are seldom destroyed by earthquake; however, they are often damaged and require reinstallation. Even moderate earthquakes may dislodge these homes from their support system (piers), allowing them to fall to the ground. Accessory structures such as awnings, decks, skirting, etc., are racked and twisted beyond repair when the home shifts off the support piers. Reinstallation of damaged manufactured homes can be quite expensive and Earthquake related fires are usually the cause of destroyed manufactured homes during earthquakes. Fires typically originate from a ruptured gas line where it connects to the home or to an appliance. When these homes are manufactured, all gas appliances are required to be secured in place. However, many times when a homeowner replaces appliances, they are not secured and become the source of ignition when the gas connection is broken by movement of the appliance during an earthquake.

In preparing a manufactured home to resist earthquakes, the principal considerations should be to:

1. Prevent the home from falling to the ground, and,
2. Prevent the movement of gas burning appliances and provide flexible gas lines.

You may wish to consider using an HCD certified Earthquake Resistant Bracing System as an effective method of bracing your home. You should also ensure that your gas burning appliances are all secured in place to resist movement during an earthquake and flexible gas lines are installed. Earthquake Preparedness also includes knowing where your utility connections are and how to turn them off if it becomes necessary.

Please beware of persons who try to sell various devices to make manufactured homes earthquake resistant. California law prohibits the sale of devices which are not HCD certified Earthquake Resistant Bracing Systems. Before you buy a bracing system, insist on verification that the system is HCD certified.

If your manufactured home fell to the ground during the recent earthquake, you will need to hire a contractor to put it back onto its support system. This will require a permit. Should you decide to install an Earthquake Resistant Bracing System a second permit will be required. Before hiring a contractor, verify the permit process with HCD and your local building department

When hiring a contractor to reinstall your home on its piers and, if desired, to install an Earthquake Resistant Bracing System, make sure you consider the following:

1. The contractor has experience with manufactured homes. Ask for references and then verify them.
2. Make sure the contractor is aware of the permitting process that will be required. Also make sure it is clearly stated in the contract as to who will be responsible for securing the necessary permits.
3. If you elect to have an Earthquake Resistant Bracing System installed, require the contractor to submit proof that the proposed system has been certified by HCD.
4. Always retain final payment until all inspections have been made, the utilities have been reconnected and turned on, and you have a written statement from the approving authority that it is okay for you to move back in.

## SHOPPING LIST

### Materials

- \_\_\_\_\_ 1/2" diameter expansion bolts
- \_\_\_\_\_ 3/8" diameter plastic tubing
- \_\_\_\_\_ Chalk or lumber crayon
- \_\_\_\_\_ Nominal 2" thick lumber
- \_\_\_\_\_ Sheets 3/8" or 15/32" thick plywood of Structural I or CDX grade
- \_\_\_\_\_ 8d common nails
- \_\_\_\_\_ 10d common nails

### Tools

- \_\_\_\_\_ 1/16" diameter drill bit
- \_\_\_\_\_ Masonry drill bit
- \_\_\_\_\_ Electric rotary impact drill or heavy-duty drill
- \_\_\_\_\_ Short-handled sledge hammer or carpenter's hammer
- \_\_\_\_\_ Adjustable crescent wrench
- \_\_\_\_\_ Measuring tape
- \_\_\_\_\_ Pencil
- \_\_\_\_\_ Eye protection
- \_\_\_\_\_ Dust mask
- \_\_\_\_\_ Noise protection
- \_\_\_\_\_ Nail gun
- \_\_\_\_\_ Electric circular saw
- \_\_\_\_\_ Vise
- \_\_\_\_\_ Electric drill
- \_\_\_\_\_ 1-1/2 to 2" hole saw

## **SPECIAL NOTES**

Earthquake upgrading will add value to your house, protect your investment, and help keep your family safe in the event of an earthquake. Though upgrading is itself a form of earthquake protection, having an upgraded structure will also allow you to obtain and maintain earthquake insurance.

You may decide to have your construction done without using a licensed contractor, however, you must obtain the building permit and you will be responsible for both the work and the workers. Craft persons may do good work, but make sure you carry worker's compensation insurance to cover them during the construction work. This kind of coverage is usually not included in a homeowner's policy.

Last but not least, see that the upgrade work conforms to other codes such as plumbing, electrical, and fire and flood. Don't make your home less safe in other respects while strengthening it against earthquakes.

### **Sources of Funds**

Different types of financing strategies can be used.

In the simplest case, foundation bolting and cripple wall strengthening can be paid for directly because the cost is not prohibitively high. If the project is more extensive, you may consider doing the work in phases as money becomes available. Remember that the most critical work should be performed first. It is often more cost-effective to perform several tasks at once because it reduces the contractors overhead cost.

#### **1. Undamaged Structures**

If the cost of the upgrading is substantial, several types of loans are available;

- a. home improvement
- b. refinancing loans
- c. life insurance loans
- d. passbook loans, and
- e. personal loans

You should consult with representatives of your bank, savings and loan, or credit union.

#### **2. Damaged Structures**

If you had damage to your home caused by the recent earthquake or subsequent after-shocks, the cost of these repairs and strengthening techniques may be covered under State or Federal disaster assistance programs. Call 1-800-462-9029 immediately. These programs operate in sequential order on the basis of eligibility and unmet need, as follows.

##### **Insurance:**

Private earthquake insurance may cover the cost of repair for earthquake caused damage and cover some of the mitigation items described in this guidebook, either as codes and standards requirements or as work encouraged by the insurance companies themselves.

**Small Business Administration (SBA):**

Based on the type and extent of uninsured earthquake caused losses and damages, individuals may be eligible for low interest rate loans for home property losses and damages of up to \$120,000 (\$100,000 for real property and \$20,000 for personal property). An additional twenty percent (20%) of the loan amount is available for approved hazard mitigation measures.

**Individual and Family Grant Program (IFG):**

Grants may be available to eligible individuals and families who are unable to meet disaster-related necessary expenses and serious needs for which assistance from other means is unavailable or inadequate. The IFG program can cover the costs of home repairs, including strengthening. Strengthening falls under “minimum protective measures” in the IFG program regulations.

**California Natural Disaster Assistance Program (CALDAP):**

Loans are available to homeowners for repair or reconstruction of real property damaged or destroyed in a natural disaster. Applicants must first exhaust insurance and all other federal and state disaster assistance in order to qualify.

**American Red Cross and other Voluntary Agencies:**

If essential needs still remain, assistance may be provided by the American Red Cross and other voluntary and private non-profit agencies who operate disaster relief programs.

**Sources of Additional Information**

- Local (City or County) Building, Planning or Public Works Departments
- City or County Office of Emergency Services
- Associated General Contractors (district office)
- Council of Carpenters (district office)
- Structural Engineers Association of California
- California Council of American Institute of Architects

## **Earthquake Preparedness**

California Office of Emergency Services

### **Coastal Region:**

Earthquake Program  
1300 Clay Street, Suite 400  
Oakland, CA 94612  
(510) 286-0895

### **Southern Region:**

4671 Liberty Avenue  
Los Alamitos, CA 90720-5158  
(562) 795-2900

1350 Front Street, Suite 2041  
San Diego, CA 92101  
(619) 525-4287

117 W. Micheltorena, Suite D  
Santa Barbara, CA 93101  
(805) 568-1207

### **Hazard Mitigation**

California Department of Emergency Services  
11030 White Rock Road  
Rancho Cordova, CA 95670  
(916) 464-2610

Federal Emergency Management Agency  
Region IX

Bldg 105 P.O.Box 29999  
Presidio of San Francisco, CA 94129  
(415) 923-7100

## **Geological**

California Division of Mines and Geology  
Dept of Conservation  
801 K Street  
Sacramento, CA 95814  
(916) 445-5716

185 Berry Street Suite 210  
San Francisco, CA 94107-1728  
(415) 904-7707

655 South Hope Street Suite 700  
Los Angeles, CA 90017  
(213) 239-0878

United States Geological Survey  
Western Region Headquarters  
Blg 3, Room 504  
345 Middlefield Road  
Menlo Park, CA 94025  
(650) 329-4390

## **WHAT IS A GEOLOGIST?**

Geologists are Earth Scientists. Their training and experience encompasses the study of rocks and minerals, stratified rocks, faults, landslides and other landforms.

Anyone who offers to practice or practices geology for the public in California must be licensed as a geologist. An engineering geologist must be additionally certified.

## **WHAT DOES A GEOLOGIST DO?**

Geologists usually specialize in fields, such as; engineering geology; exploration for oil and natural gas or for mineral deposits; ground water and environmental geology. Geologists conduct investigations and provide interpretative geologic services related to the origin, composition, history and structure of the earth. Consumers generally require the services of Engineering Geologists, whose work involve geologic hazard investigations for problems which include landslides, ground subsidence, faults, earthquakes and erosion potential.

## **WHERE DO YOU FIND A REGISTERED GEOLOGIST OR ENGINEERING GEOLOGIST?**

To find a qualified professional: 1. Check the yellow pages. Ask your local or county building department for the names of consultants who have worked in your area or call professional associations, 2. ask for the consultant's state registration number or check with the State Board of Registration about the status of the consultant's license, 3. contact former clients and ask their opinions about the quality of the consultant's work, 4. understand the terms of the employment, and 5. have a written contract that specifies the terms and performance expected and includes time periods. Ask for itemization of any additional charges for drilling, laboratory testing and trenching. If the consultants ask for a retainer, know its purpose and whether it will be applied to the bill or charged separately.

## **WHY DO YOU NEED AN ENGINEERING GEOLOGIST?**

The California Division of Mines and Geology is a state agency that provides information and publications on geology, and geologic hazards. Its Publications and Information Office is located in Sacramento, call (916) 445-5716. In Los Angeles call (213) 239-0878 or in San Francisco call (415) 904-7707.

The state requires county governments to have in their general plan, a seismic safety element that contains earthquake and related secondary hazard information. City and county planning or building departments are the local agencies to contact.

**Contractor's Board Page**

**Contractor's Board Page**

